NuFact2015

WG3 Summary

(Accelerator Physics)

Pavel Snopok, IIT/Fermilab, US
Jingyu Tang, IHEP, China
Chris Densham, STFC, UK

WG3 presentations

- 6 plenary talks
- 27 parallel talks
- Panel discussions
- WG3 summary discussions

HIGHLIGHTS OF TALKS

Plenary talks

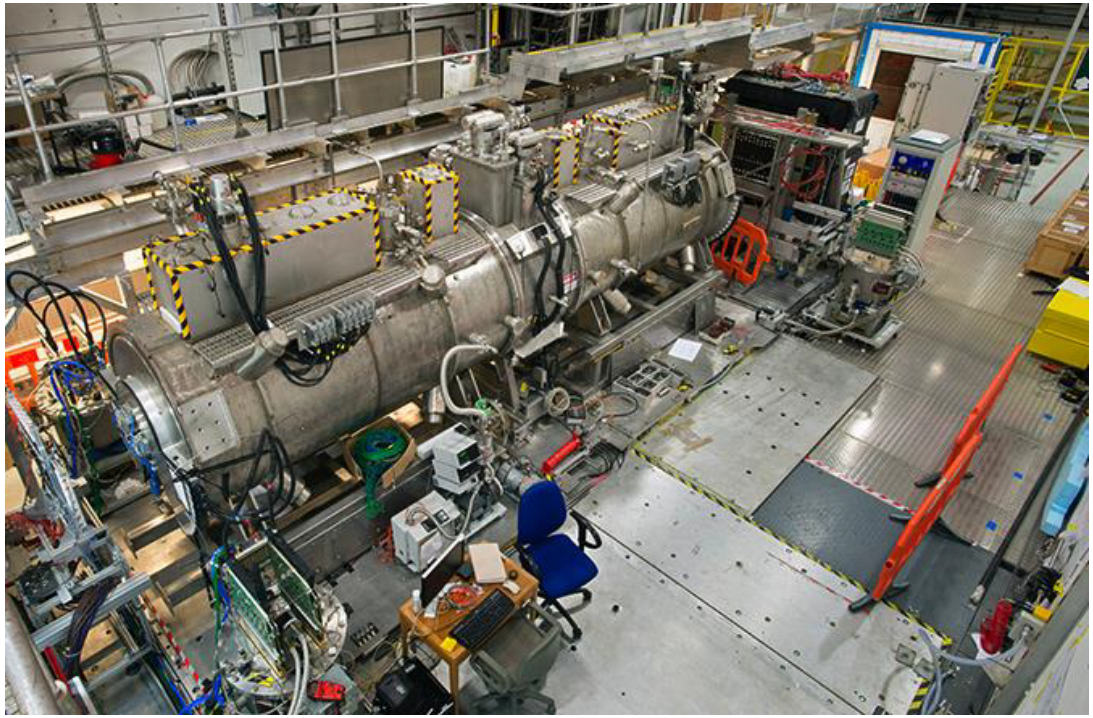
- Tuesday, MOMENT synergies with other projects (Jingyu Tang, IHEP)
- Tuesday, MAP/MICE status (Mark Palmer, Fermilab)
- Thursday, Current Status of the Fermilab Neutrino Beamlines (Craig Moore, Fermilab)
- Thursday, Fermilab Proton Driver (Milorad Popovic, Fermilab)
- Saturday, Future Accelerator-based Neutrino Physics in Asia (Takashi Kobayashi, KEK)
- Saturday, Future Accelerator-based Neutrino Physics in America and Europe (Kenneth Long, Imperial College London)

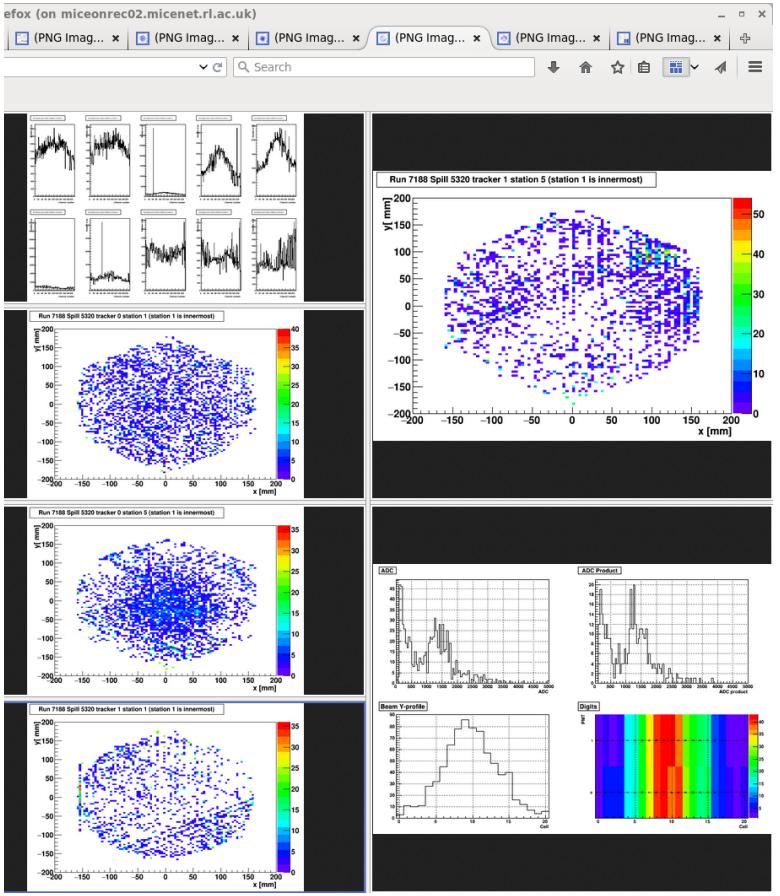
MICE Progress

- MICE construction (Colin White, University of Strathclyde)
- MICE Step IV (Milorad Popovic, Fermilab)
- MICE Demonstration of Ionization Cooling (Jean-Baptiste Lagrange, ICL/Fermilab)
- MICE trackers and magnet (Melissa Uchida, Imperial College London)

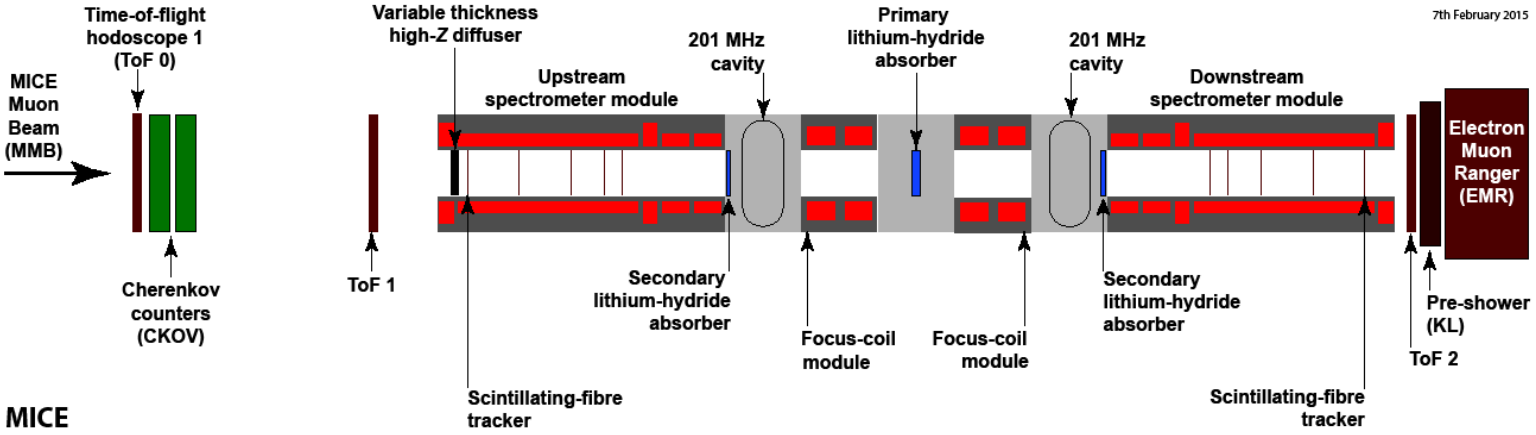
- MTA status and progress (Derun Li, LBNL)

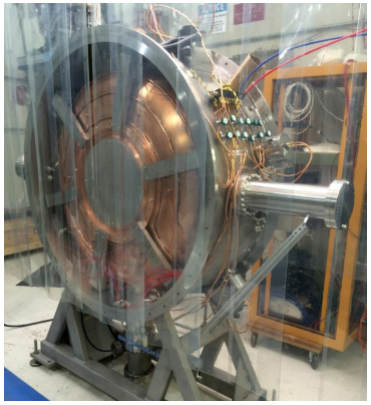
- Step IV: hardware and infrastructure installation completed, and started commissioning
- All detectors have been commissioned and are being used for magnet alignment

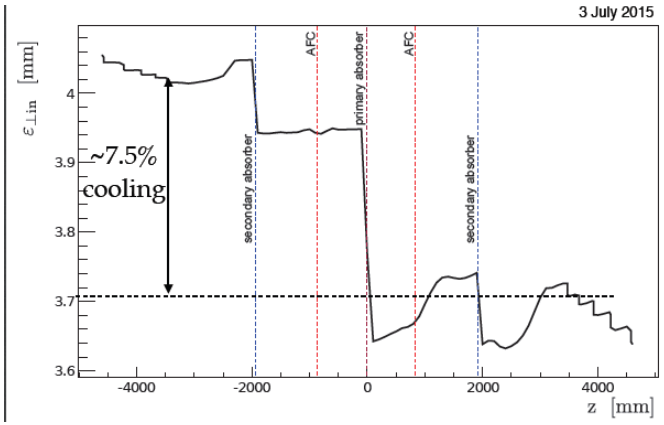




- Cooling Demonstration: will start installation in June 2016
- Hardware (especially RF) development is going well
- Simulations show: about 4.0-7.5% in emittance cooling



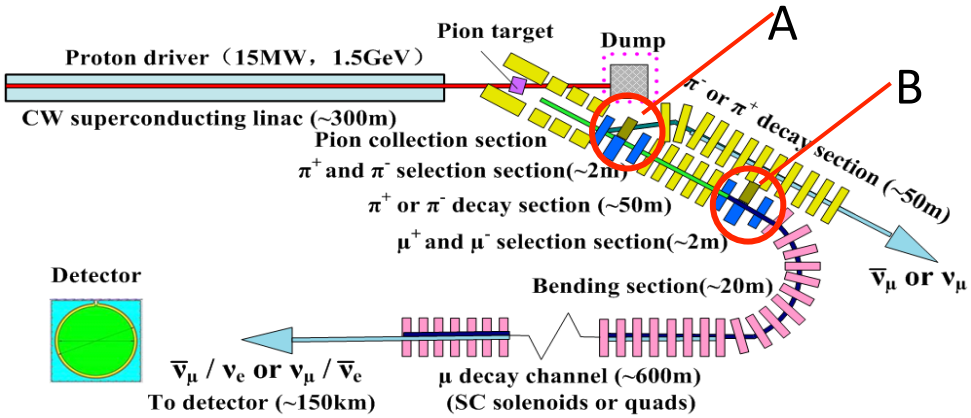


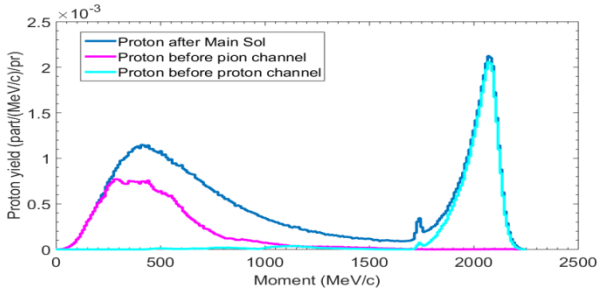


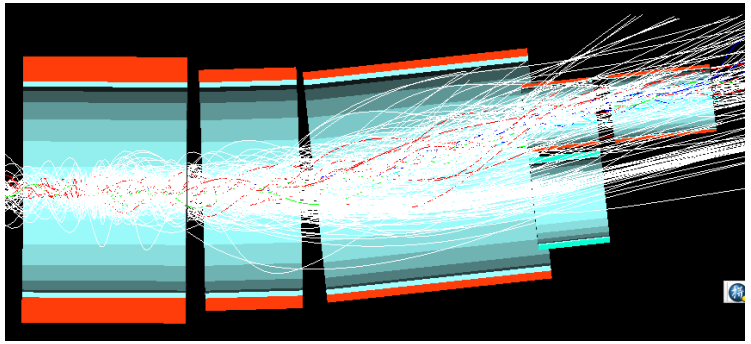
MOMENT

- MOMENT as multiple neutrino sources (Ye Yuan, IHEP)
- Studies on pion/muon capture at MOMENT (Nikos Vassilopoulos, IHEP)
- Cooling structure at the MOMENT target (Jianfei Tong, IHEP)
- Protons after bombarding the target at MOMENT (Cai Meng, IHEP)
- Studies on charge selection at MOMENT (Yingpeng Song, IHEP)

- Besides a muon-decay neutrino beam: a competitive pion-decay neutrino beam and a DAR neutrino source.
- Optimization design study on pion production/capture and spent protons: ≈5 MW protons potentially being extracted to an external dump.
- Cooling schemes for the inner shielding of the target station: pressured He gas may work at 15 MW proton beam.
- Charge selection for both μ^+/μ^- and π^+/π^-: feasible but very difficult for large emittance and momentum range



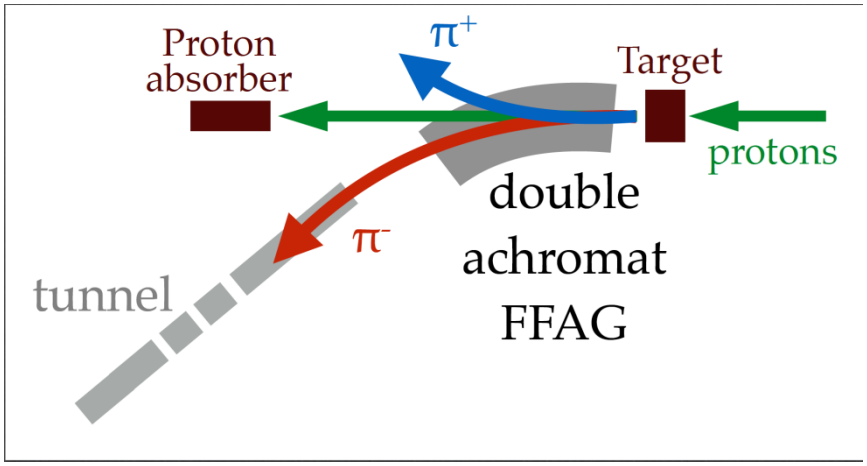


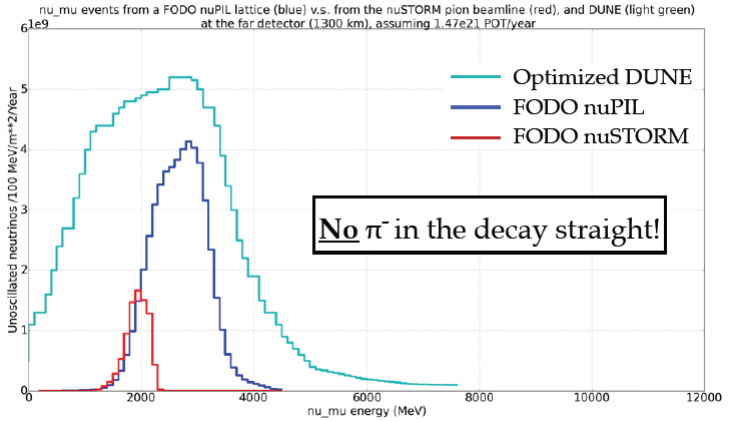


nuSTORM/NuMAX

- nuSTORM overview (Alan Bross, Fermilab)
- Decay ring design for long baseline NF a la NuMAX (Jaroslaw Pasternak, Imperial College/ RAL-STFC)
- Neutrinos from pion beam line (Jean-Baptiste Lagrange, Imperial College/Fermilab)

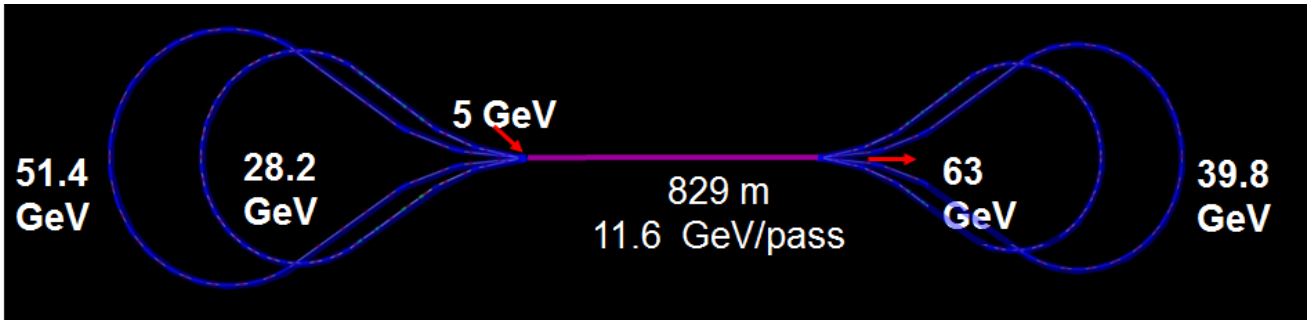
- nuSTORM for interaction measurement and sterile neutrinos continues to develop
- The nuPIL concept potentially offers the option to simultaneously support a LBL program and a SBL program with neutrino beams of unprecedented precision.
- Decay ring design for NF based on NuMAX: shorter ring, limited by kickers



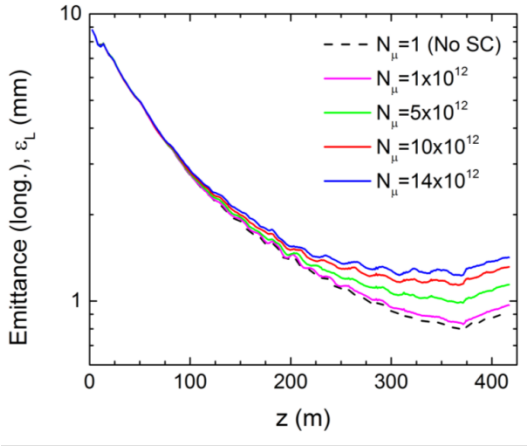


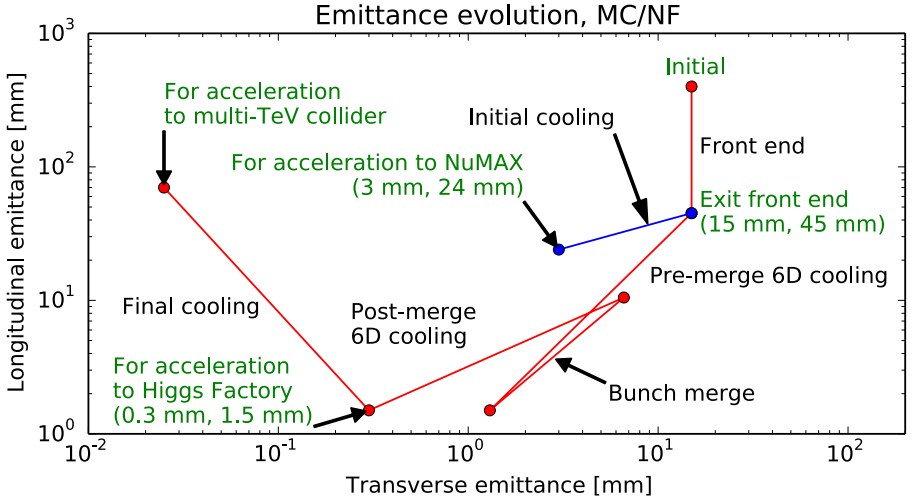
Muon Cooling and Acceleration

- Muon acceleration for NF/MC (Alex Bogacz, Jefferson Lab)
- High-intensity and high-brightness muon beams (Pavel Snopok, IIT/Fermilab)
- Hybrid cooling channel (Diktys Stratakis, BNL)
- Final cooling (Mark Palmer, Fermilab)



- Bright muon source design to meet NF and MC requirements: target, front end, 6D cooling, final cooling
  - end-to-end simulation
  - engineering constraints
- Hybrid cooling for MC: gas-filled RF for breakdown control, space-charge effects accounted for
- Updated muon acceleration schemes both for NuMAX and for Higgs Factory
- Alternative final cooling schemes to reach MC cooling goals

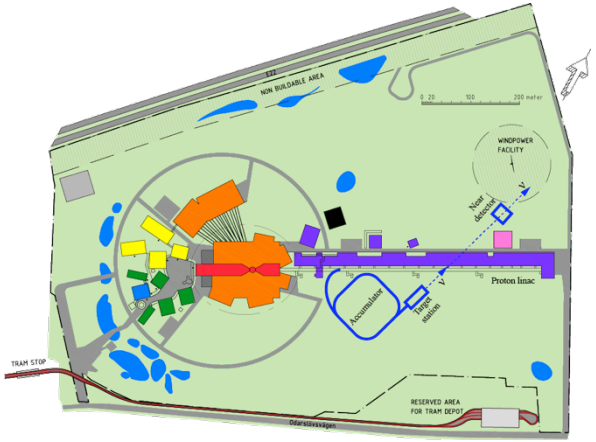


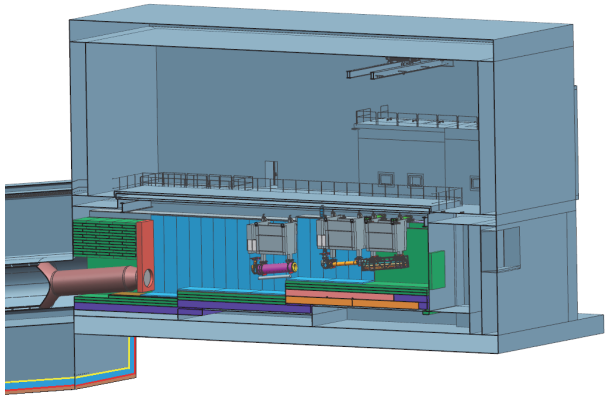


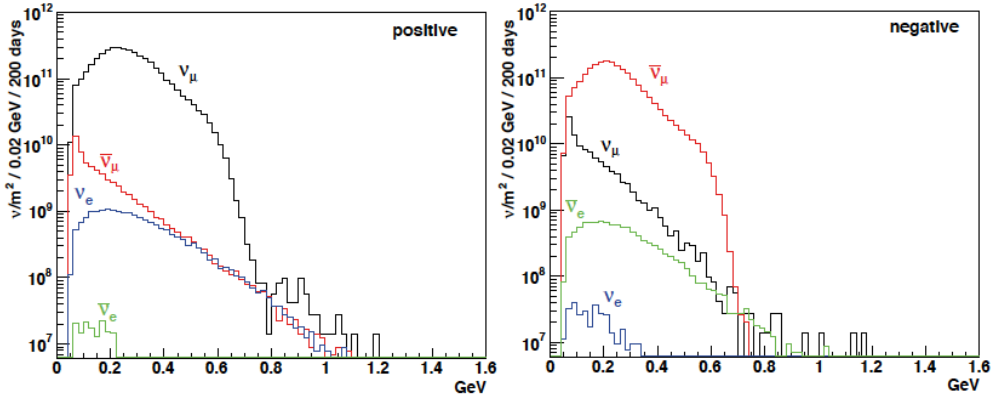
ESSnuSB, LBNF, Targetry

- ESS neutrino superbeam (Marcos Dracos, IPHC-IN2P3/CNRS)
- LBNF neutrino beams (James Strait, FNAL)
- Latest results on in-beam W powder target at CERN (Ottone Caretta, RAL)
- Targets for high-intensity muon sources (Kirk McDonald, Princeton University)

- ESS is the most powerful proton machine under construction: potential to add a neutrino facility later for low-energy neutrinos
- LBNF neutrino beamline: well developed but further optimization needed, 1.2 MW (PIP-II) upgradable to 2.4 MW (PIP-III)
- Studies and in-beam test (at CERN) of powder target: powder lift by beam observed.
- Targets for high intensity muon beams and neutrino beams reviewed: carbon target competitive in MW level.



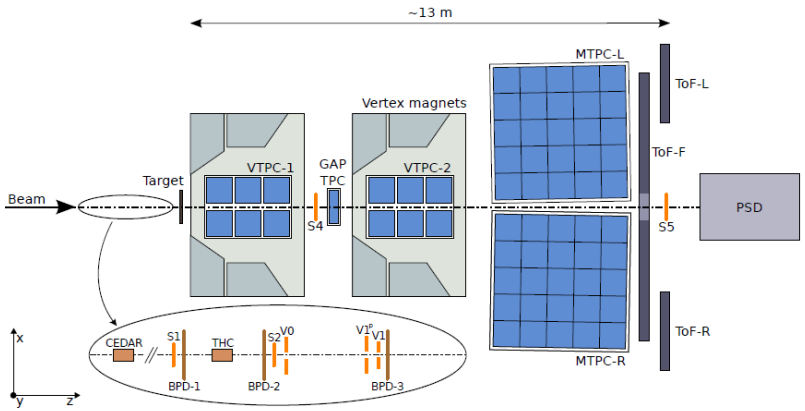


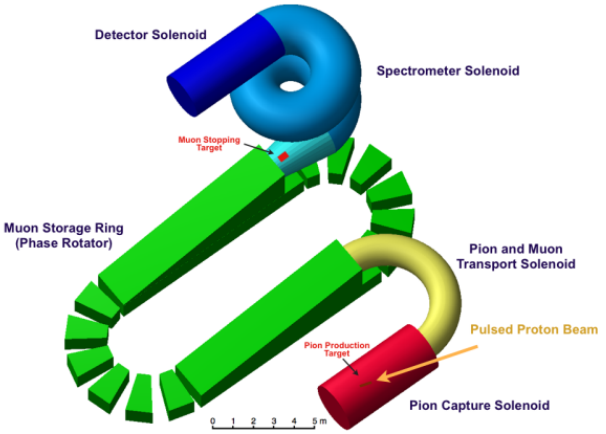


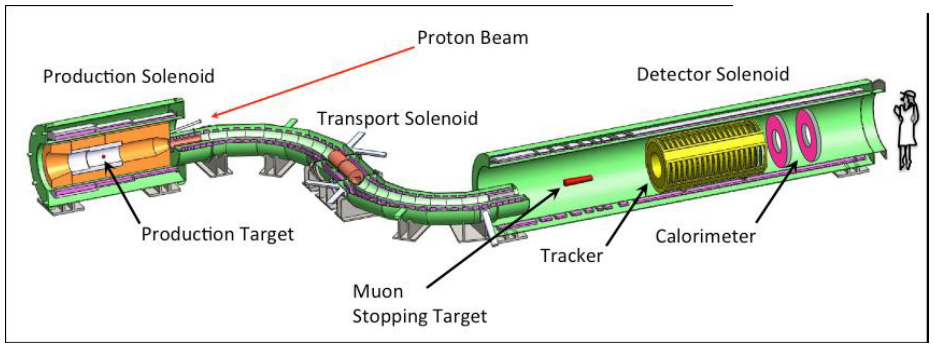
Joint Sessions

- J123: Prospects for reducing beam flux uncertainties with hadron production experiments over the next 10 years (Alessandro Bravar, Université de Genève)
- J34: PRISM: Progress on R&D studies (Jaroslaw Pasternak, Imperial College/RAL-STFC)
- J34: Mu2e (Vladimir Nagaslaev, Fermilab)
- J34: J-PARC high intensity neutrino beam (Tetsuro Sekiguchi, Takashi Kobayashi, KEK)
- J34: Muon beam line for COMET (Ye Yang, Kyushu University / KEK)
- J34: A novel neutrino beamline for the measurement of the electron neutrino cross section (Francesco Terranova, Univ. of Milano-Bicocca and INFN)

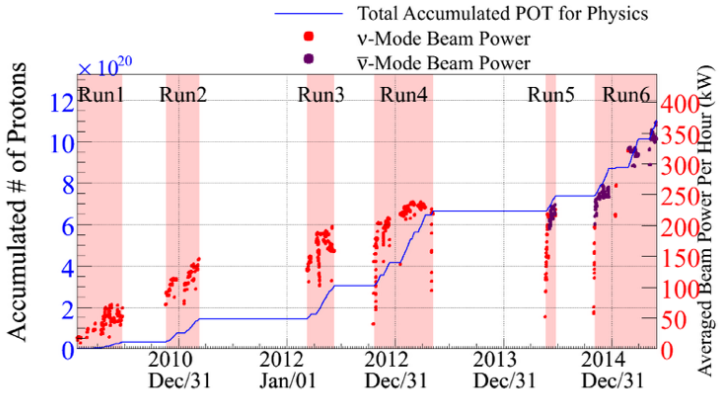
- Hadron production measurement (NA61): important input for oscillation experiments, such as LBNF/DUNE and T2HK
- PRISM/PRIME for CLFV: reference design, major challenges addressed
- Mu2e finishing technical design, civil construction in progress, accelerator upgrades on track

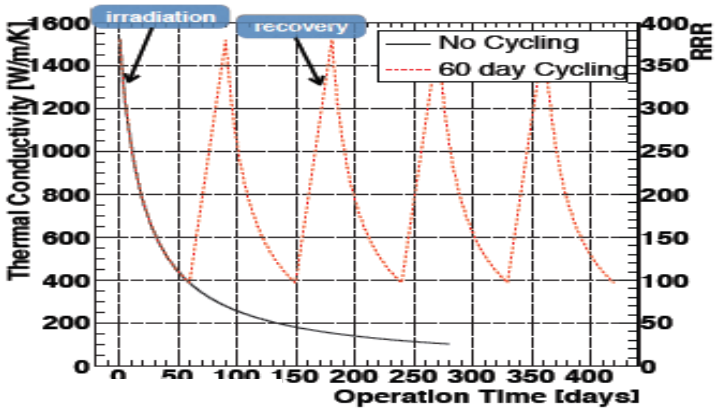


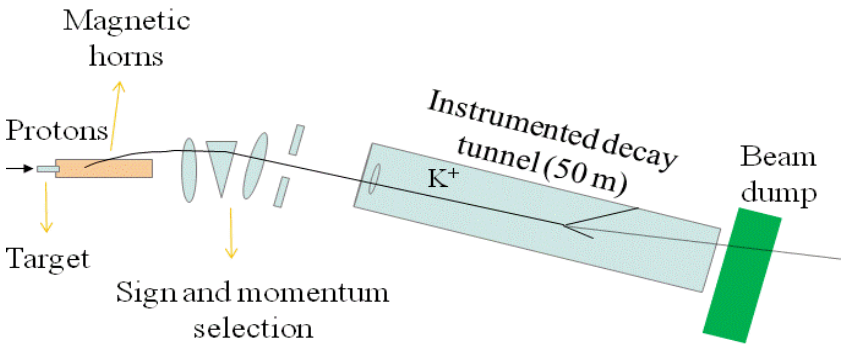




- J-PARC neutrino beam: measures for 750 kW operation (2018), future 1.3 MW upgrade discussed (2026); cooling capacity and radioactive material are the key issues.
- COMET capture solenoid: quench every 60 days, recovery by warm-up
- A novel neutrino beamline: using K^+ decay and e^+ online monitoring to reduce intrinsic flux uncertainty







QUESTIONS

MICE

- MICE started collecting data in Step IV configuration
- New question: what would be the best way to present results obtained by next year

Target/capture

- What is the path to a multi-MW target/capture system?
  - Progress on all subsystem studies, summary in K. McDonald's talk
  - Other studies:
    - W powder target (see O. Caretta talk)
    - RaDIATE collaboration
- What are the limits of the carbon target?
  - Recent indications are that operation of graphite at high temperature (radiation cooling, ~ 2000 K) would permit long life even at 4-MW beam power (deserves verification in beam tests.)

Acceleration

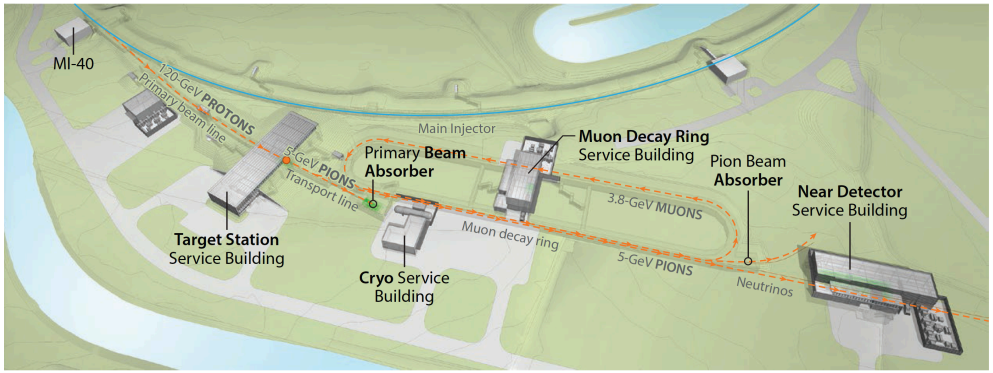
- What is the optimum muon acceleration scheme for the Neutrino Factory with respect to feasibility, performance and cost?

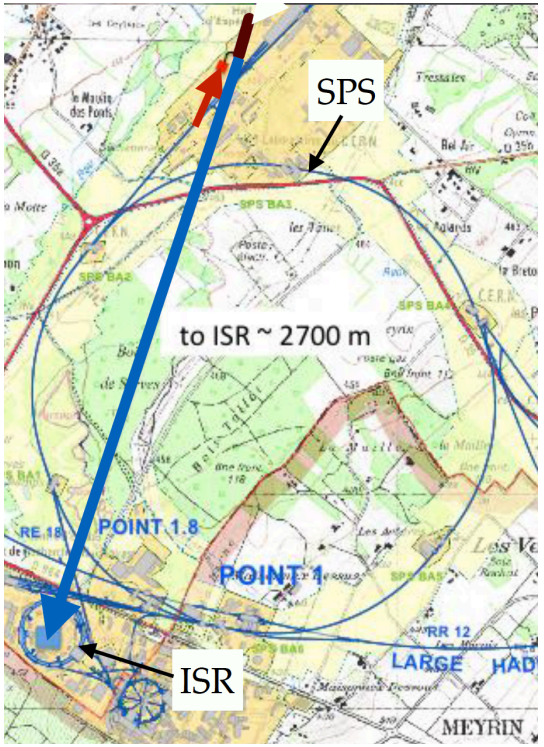
- Conceptual schemes for 5 GeV Neutrino Factory (a la NuMAX)
  - Scheme I - SRF efficient design based on multi-pass Dogbone RLA
    - Linac (255 MeV – 1.25 GeV) Longitudinal compression
    - Delay/Compression Chicane – Transition from 325 to 650 MHz SRF
    - RLA (1.25 – 5 GeV) 4 droplet Arcs and multi-pass linac
  - Scheme II – Conceptual design based on dual-use (H^- and muons) linac. Further compatibility studies on:
    - H^- dynamics in a strongly focusing solenoid based FOFO channel, e.g. effect of solenoid fringe fields on H^- ion stripping
- Optimized RLA scheme for Higgs Factory and beyond (MC):
  - Number of passes limited by beam loading
  - RLA with multi-pass arcs
  - TeV scale acceleration – Rapid Cycling Synchrotrons

nuSTORM

- What is the best solution/design for the nuSTORM facility (performance, cost)?
- How to generate short proton pulse for nuSTORM at CERN? What is the location of the far detector at CERN?

- CDR developed for siting at Fermilab
- EOI for developing a siting option at CERN presented to CERN SPC





- Fermilab: 120 GeV protons from MI
- CERN: 100 GeV protons from SPS
  - ~2/3 flux in CERN siting

New questions related to nuSTORM/nuPIL

- Should the workshop expand its emphasis and consider extensions to conventional neutrino beams moving beyond horn-focused beams? What is the physics performance of non-conventional neutrino beams?
- Can a muon-based neutrino beam be operated parasitically to a high-power pion-based neutrino beam (nuPIL)?

Muon experiments

- What are the optimum beam designs for next generation muon experiments based on current and future proton beams? =>
  - Discussion needs to continue with more interaction between WG3 and WG4 groups
- What are the possible applications of (cooled) muon beams? =>
  - New question: How would the performance of muon experiments be improved by using muon cooling? (Mu2e, PRISM)
- Can we design the capture/front end system, which would be beneficial for many experiments?
  - Related new question: in the next couple of years Fermilab will have a muon beam. What are the additional applications for this beam?

ESS

- Is there a possible solution for an ESS driven proton driver for the SB and/or NF?
  - Yes to both questions, see also presentation by M. Dracos
  - next step would be the design study

Many thanks to all the speakers and participants!